Claims

[c1] Method of charging Li-based batteries by constant current and then by constant voltage to minimum current, with following operations:

a. Measurement of battery ohmic resistance

b. Setting of battery overvoltage protection value, and

c. Setting of minimum charging current depending on battery ohmic resistance and overvoltage protection.

[c2] Method of charging Li-based battery of claim 1, wherein said overvoltage protection is specified as difference between maximum voltage and instantaneous open-circuit voltage at battery terminals after 1 to 10 ms of current change.

[c3] Method of charging Li-based battery of claim 1, wherein said minimum charging current is chosen as ratio of minimum overvoltage protection to battery ohmic resistance

[c4] Method of charging Li-based battery of claims 1-3, wherein maximum voltage, V_{max}, ranges between 4.0 and 4.2 V per cell.

[c5] Method of charging Li-based battery of claim 1, wherein constant voltage is instantaneous open-circuit voltage.

[c6] Method of charging Li-based battery of claim 1, wherein constant voltage equals maximum voltage.

[c7] Method of charging Li-based battery of claim 1, wherein constant

voltage equals maximum voltage plus product of minimum charging current and ohmic resistance.

[c8] Method of charging Li-based battery of claim 1, wherein minimum overvoltage protection is 0 to 50 mV.

[c9] Method of charging Li-based battery of claim 1, wherein tolerance of supporting constant voltage has to be less than minimum ovevoltage protection.

[c10] Method of charging Li-based batteries of claims 1, wherein the minimum charging current reaches 0.6–0.05C rate.

[c11] Method of Li-based battery equalization in process of battery discharging, wherein individual lithium cell is periodically connected to battery lithium cell having minimum discharging voltage until voltage of two cells is getting equal to dynamically preselected voltage.

[c12] Method of Li-based battery equalization in process of battery charging, wherein individual lithium cell is periodically connected to battery lithium cell having maximum charging voltage until voltage of two cells is getting equal to dynamically preselected voltage.

[c13] Method of Li-based battery equalization, wherein three series-connected Ni-based batteries are connected in parallel to each

Li-based cell, and Ni-based cells are part of charging device.

[c14] Method of hybridizing lithium battery and creating one hybrid power source, wherein each lithium cell permanently contains three series-connected Ni-based cells, wherein Li-based cell and Ni-based cells have parallel connection.

[c15] Method of charging Li-based battery of claims 11 and 12 by constant current, and constant voltage, wherein charging is interrupted when charging current reaches stationary value.

[c16] Li-based battery control method that contains

a. Measurement of battery voltage

b. Measurement of ohmic resistance

c. Measurement of chemical resistance, and

d. Measurement of open-circuit voltage.

[c17] Battery control method of claim 14, wherein ohmic resistance is measured as ratio of two voltage differences corresponding to two current differences measured within 1- to 10-ms interval.

[c18] Battery control method of claim 15, wherein one of two currents is zero.

[c19] Battery control method of claim 14, wherein chemical resistance is measured as ratio of two voltage differences sampled prior to 10 ms and after 150-ms current change corresponding to two current differences.

[c20] Battery control method of claim 14, wherein one of two currents is zero.

[c21] Battery control method of claim 14, wherein nonstationary open-circuit voltage is defined as difference between terminal voltage and product of sum of ohmic and chemical resistances, and current.

[c22] Battery control method of claims 14 and 19, wherein nonstationary open-circuit voltage is used to recognize battery state-of-charge.

[c23] Battery control method of claim 14, wherein electrical double layer capacity is measured by sampling chemical polarization for 10 to 15 ms after current interruption, and obtaining ratio of product of current and time interval to chemical polarization difference for this time interval.

[c24] Method of charging and controlling Li-based battery of claims 1, 11, and 14 wherein said battery is Li-ion battery.

[c25] Method of charging and controlling Li-based battery of claims 1, 11, and 14, wherein said battery is Li polymer battery.

[c26] Method of charging and controlling Li-based battery of claims 1, 11, and 14, wherein said battery is metallic Li battery.